ELECTRON BEAM IRRADIATION PRESERVATION OF CATTLE HIDES IN A COMMERCIAL-SCALE DEMONSTRATION

by

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ABSTRACT

In 1999, the USDA approved the use of electron beam and gamma ray irradiation for the cold pasteurization of red meat including the elimination of *E. coli* O157-H7 in hamburger. Titan, Incorporated, of San Diego has contracted with a major red meat producer to construct the first electron beam irradiation facility dedicated to this purpose. This opens up the possibility of applying electron beam technology to preserve cattle hides in order to eliminate environmentally hazardous brine curing in these same packing plants. With this in mind, Titan entered into a Memorandum of Understanding with the Agricultural Research Service to conduct an industrial-scale evaluation of the use of electron beam irradiation for cattle hide preservation. We have conducted a one-hundred-and-fifty-hide matched-side experiment to evaluate preservation, leather quality and yield of electron-beam-preserved cattle hides as compared to brine-cured hides. The hides in this study were individually identified immediately after slaughter in Schuyler, NE, trucked to a tannery in St. Joseph, MO, to prepare them for irradiation, trucked to Cranbury, NJ, for irradiation and then returned to St. Joseph to be tanned. A total of three weeks elapsed between hide removal and tanning. After storage at room temperature, all of the hides appeared to be as fresh and clean as they were just after flaying. Weight, area and visual quality were measured at various stages throughout the process. With the exception of draw, which was considerably better on the irradiated sides compared to the brine sides, all of the parameters measured were equivalent for both preservation treatments. An analysis of the results obtained will be presented along with the potential impact of cattle hide irradiation on the tanning and packing industries.

INTRODUCTION

In 1999 the USDA approved the use of electron beam and gamma ray irradiation for the cold pasteurization of raw meat and meat products such as ground beef, steaks, and pork chops to reduce significantly or eliminate *E. coli* O157:H7 and other hazardous microorganisms.[1] This not only opened up the potential for economically treating red meat at packing plants with electron beams to eliminate microbial contamination but it also provides an opportunity to apply electron beam technology to preserve cattle hides. This could replace the environmentally unfriendly brine curing process in these same packing plants. A number of reports have been published that describe successful trials of preserving cattle hides using electron beam and gamma irradiation.[2,3] These tests to date have only included a small number of hides. This report describes a commercial-scale demonstration conducted to directly compare the quality of leather produced from electron-beam-irradiation preserved cattle (**Evergreen™**) hides with brine-cured (salt preserved) cattle hides.

The objective of the demonstration was to show the efficacy of preserving cattle hides with electron beam irradiation and to determine if there was also an increased area yield with irradiated hides compared to brine cured hides. An

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[a]Mention of brand or firm name does not constitute an endorsement by the U.S. Department of Agriculture over others of a similar nature not mentioned.

increased area yield of fresh hides compared to brine cured hides was reported by Feairheller, et al. in 1975.[2]

Hides must be quickly preserved after flaying to prevent bacterial damage that could ultimately result in lower quality leather. As a result the majority of US hides are brine-cured within hours of slaughter. While brine curing has been used for centuries it is not without negative side effects. Most importantly, the use of brine curing creates substantial effluent treatment problems for both the packer and the tanner. For each hide cured with brine the packer must dispose of from one to two gallons of saturated brine in his effluent. When the tanner soaks a salt-cured hide to remove the salt, not only does this add ten pounds of dissolved solids in the effluent but a wide variety of bacteria originally present on the hide begin to rapidly multiply. In addition brine raceways contain halophilic bacteria that prosper in a concentrated salt environment. These organisms generally contain pigments producing a condition known as "red heat" on cured hides during storage. The condition is associated, by most tanners, with bacterial damage to the hides and this association was confirmed in work done by Vreeland et al.[3] At certain times of the year, this can affect up to 90% of brined hides.

As a result, when practical and possible, fresh hides are the preferred raw material for many domestic tanners. Using ice and refrigeration, hides can be adequately preserved for 2 to 3 days, permitting a limited amount of domestic transport. However, the logistics of shipping and production permit only a fraction of domestic hides to be used as fresh. It can take several months to deliver brine-cured hides to the Far East, where more than two thirds of all exported US hides are shipped. More than eighty percent of these hides are shipped brine-cured. The other twenty percent are tanned and shipped as bluestock. What is clearly needed is a non-salt alternative to hide curing that is cost-competitive and non-polluting.

Overview of The Demonstration Protocol

The demonstration protocol used one hundred fifty hides. Each hide was sided and alternating matched sides were preserved by either the Evergreen process or in a commercial brine curing facility. Left and right sides were directly compared for grain quality, weight and area yield at several stages of processing.

The hides in this study were obtained at the Excel plant in Schuyler, NE. The hides were sided (cut in half down the back bone) and one half was trucked to St. Joseph, MO, to prepare them for irradiation and the other half was taken to a brine cure raceway. The hides to be irradiated were shipped 1,300 miles to an irradiation facility in Cranbury, NJ, and returned to St. Joseph where they were stored at room temperature for twenty-one days. Commercially, it is expected that storage of Evergreen hides can safely be extended to several months. The sides were tanned to bluestock in St. Joseph and then retanned and finished at the Prime facility in Berwick, ME. Physical testing of the leather was done at the USDA laboratory in Wyndmoor, PA.

Materials and Methods

Selection of Hides

Hides were selected from the overhead chain conveyer after cooling and fleshing. To assist in producing as uniform final leather as possible the hides were selected as close to 65 lbs as practical. Each hide was sided (split down the backbone). Both of the resulting sides were then punched with the same unique identifying series of punch holes. In addition, the side that was to be brine-cured was identified with a one inch diameter punch hole located within six inches of the backbone and six inches from the tail. The weight of each individual side was recorded and then each side was placed in the appropriate five-foot cube container. The sides to be irradiated were shipped to the Prime Tanning Company tannery in St. Joseph, MO, in a refrigerated truck (approximately 4 hours). The sides to be brine-cured were taken to a commercial contract brine raceway, cured, palletized and then shipped to the same tannery.

Preparation for Irradiation:

The initial step in the Evergreen process is to treat the hides with a bactericide. This was done in a 20-foot diameter commercial drum containing a 100% float of water, 0.3% Proxel GXL and 0.05% of Triton X 100 surfactant. The drum was run at 4 rpm for one hour. The sides were dropped from the drum and then moved to a bluestock wringer to be wrung prior to being individually bagged in plastic. There was a delay in application of bactericide of twelve hours from the time the first hide was removed until all of the sides were in the drum. In a commercial operation this delay would be less than one hour. The sides were folded in half along the backbone and once more from head to tail forming four layers of hide at the thickest points. They were then folded a third time creating a total of eight layers of hide in most areas. This configuration of hide layers required double-sided irradiation instead of single sided.

Irradiation of the Hides.

After the application of bactericide the sides were transported by truck 1,300 miles from St. Joseph to the irradiation facility in Cranbury, NJ.

Preparation of Bluestock

After 29 days storage, all of the brined and irradiated sides were processed together from the soak all the way through tanning. After tanning the sides were removed from the tanning drum and wrung. They were measured for thickness and area on the conveyer coming out of the wringer and evaluated for general quality. This latter evaluation was based on the amount of damage to the grain from ringworm, mold, stains, brands above normal butt brands, hair, cuts, scratches and other physical damage on a scale of 1 to 5 (1 good, 5 poor) based on the experience of the graders.

In order to maximize the number of matched pairs that could be recovered at the end of the demonstration all the blue-stock was forced into a single final leather product. All sides were split to 2.1 mm and shaved to 1.8 mm. As a result some of the sides ended up being very thin in the flanks. However, since this was a matched side test this was true of both the brine-cured side and matching irradiated side. Random samples were taken from both types of sides for pH, moisture, chrome, and chrome leachibility. The bluestock was separated into matching pairs and all of the sides were evaluated for quality.

Physical Testing of Crust Leather (USDA)

Samples from all of the matched pairs in the crust were tested for tensile strength and elongation. Physical testing of leather samples for tensile strength and ball burst was done on an Instron Model 1122. These procedures are described in ASTM Standard D 2209-80, Tensile Strength of Leather (approved 1976) Vol. 1, CRC Press, Inc., Boca Raton, FL (1983). Elongation data were extracted from the test results for physical strength.

Results and Discussion

Hide Selection

Hides were selected from the overhead chain conveyer after cooling and fleshing. To assist in producing as uniform final leather as possible the hides were selected as close to 65 lbs as practical. The average hide weighed 64.2 lbs. The variation in weight is shown in Table I. Eighty-Six percent of the hides were within 5 pounds of the target selection. Each hide was sided (split down the backbone). Both of the resulting sides were then punched with the same unique identifying series of punch holes. In addition, the side that was to be brine-cured was identified with a one inch diameter punch hole located within six inches of the backbone and six inches from the tail. The weight of each individual side was recorded and then each side was placed in the appropriate five-foot cube container. The sides to be irradiated were shipped to the Prime Tanning Company tannery in St. Joseph, MO, in a refrigerated truck (approximately 4 hours). The sides to be brine-cured were taken to a commercial contract brine raceway, cured, palletized and then shipped to the same tannery.

TABLE I
Range of Fleshed Hide Weights from 64.2 lb Average. Excel, Schuyler, NE

Variation from Average, lbs	Number of Hides	Percent of Total	Percent Cumulative
1	27	18.0%	18.0%
2	30	20.0%	38.0%
3	28	18.7%	56.7%
4	26	17.3%	74.0%
5	19	12.7%	86.7%
6	9	6.0%	92.7%
7	5	3.3%	96.0%
8	4	2.7%	98.7%
9	0	0.0%	98.7%
10	1	0.7%	99.3%
11	0	0.0%	99.3%
12	1	0.7%	100.0%

Preparation for Irradiation

The initial step in the Evergreen process is to treat the hides with a bactericide. This was done in a 20-foot diameter commercial drum containing a 100% float of water, 0.3% Proxel GXL and 0.05% of Triton X 100 surfactant. The drum was run at 4 rpm for one hour. The sides were dropped from the drum and then moved to a bluestock wringer to be wrung prior to being individually bagged in plastic. There was a delay in application of bactericide of twelve hours from the time the first hide was removed until all of the sides were in the drum. In a commercial operation this delay would be less than one hour.

Two unplanned variations were experienced in this test and both occurred during this step in the process. It was planned that each side would be folded flat twice, resulting in four layers of hide about one inch thick. Theoretical considerations, which have previously been confirmed by actual measurements of dose distributions through the layers of cattle hides, show that this would be the optimal configuration for irradiation. Within a stack of one to five layers of hide the distribution of radiation (low max/min ratio) within the stack would be relatively uniform. The bagging material was prepared to accommodate a stack no more than five feet in length. This was done to accommodate the material handling system of the irradiator that was used in this demonstration. However, most of the hides, when folded twice, were longer than five feet and as a result the hides did not fit into the plastic bags. Hide length is not an integral part of the Evergreen process and longer lengths would not create a problem in a facility specifically manufactured for irradiation of cattle hides. In this case the sides had to be folded a third time creating eight layers instead of four. For this configuration of hides double-sided irradiation was necessary. Consequently there were some concerns at this stage about the overall impact of this on the test results. After folding and placing the sides inside the plastic bags, the bags were partially evacuated and then thermally sealed. Unfortunately the sealing apparatus performed erratically, sometimes sealing well the first time and sometimes burning through the plastic and requiring three or four attempts to make a seal. This caused concern that some of the samples would not be adequately sealed to prevent recontamination with bacteria during storage. To overcome this we taped over each seal with duct tape. It is not anticipated that hides will be individually packaged in a commercial operation so these problems are inherent only in the demonstration.

Irradiation of the Hides

After the application of bactericide the sides were transported by truck 1,300 miles from St Joseph to the irradiation facility in Cranbury, NJ. While this caused a delay of forty-eight hours between application of the biocide and irradiation, no problems were anticipated. In commercial operation with an on-site facility this delay would be less than four hours. The two sided irradiation of the sides at the irradiation facility proceeded normally and within two hours after the sides were removed from the truck they were on their way back to St. Joseph, MO.

The consequence of double-sided irradiation is that the two doses of irradiation are cumulative within the irradiated sample. Where the total thickness is less than optimal the interior dose could become high enough to reduce the strength of the leather made from these sides. If the sample is too thick then the interior will be under-dosed and this could jeopardize the preservation of the side.

Since we had folded the sides into eight layers they had to be irradiated from two sides. In order to minimize the dose at the intersection of the two-sided irradiation in the center of the folded side and at the same time ensure a preservation dose throughout the hide, we elected to use a slightly lower entrance dose (1.4 Mrad instead of 1.5 Mrad) than planned. The machine we were using did not have a variable voltage so we had to use 10 MeV. This meant that a portion of some sides would be overdosed in the center and a few might be under-dosed. Empirically the entrance dose for each side was measured at 1.4 MeV. In thin areas the exit dose also measured at 1.4 MeV. In the fully folded eight layers of hide thickness there was no measurable exit dose. It was expected that after this treatment the preservation would be maintained and any loss of strength in the leather produced from these sides would be negligible.

The optimal treatment for a cattle hide would be a single-sided irradiation dose distributed over a hide folded twice, resulting in a maximum thickness of four layers (cattle hides are not uniform within a hide nor from hide to hide). Four layers would accommodate bulls with thick necks as well as light heifers. A uniform configuration in a stack of folded hides is not possible to obtain beyond two folds. With two folds, the thin areas of hides along the belly, for example, can be folded easily over the thicker backbone area, thereby making a relatively homogeneous configuration. The resulting four layers are also more economical and practical from a material handling perspective than any configuration with less than four layers. Single sided irradiation through up to four layers of hide would provide the proper max/min ratio dose, but it is not practical much above one inch.

Preparation of Blue-stock

Twenty-one days after slaughter the sides were removed from the bags for tanning. With one exception every side smelled and appeared visually to be just as fresh as when it was sealed into the bag. A single side smelled musty suggesting that fungal growth had started on that side. In the future we would recommend the addition of a fungicide to the bactericide used in the irradiation pre-treatment. This recommendation is not only based on this result but also on previous observations. In earlier long-term preservation studies, extending more than eight months under refrigeration, the first sign of preservation loss was growth of molds on the surface. Fungal organisms are generally more resistant to irradiation than bacteria.

Processing the sides to the blue proceeded normally. All sides, brined and irradiated, were processed together from the soak all the way through tanning. After tanning the sides were removed from the tanning drum and put through the wringer. They were measured on the conveyer coming out of the wringer for thickness, area and general quality. This latter evaluation was based on the amount of damage to the grain from ringworm, mold, stains, brands above normal butt brands, hair, cuts, scratches and other physical damage on a scale of 1 to 5 (1 good, 5 poor) based on the experience of the graders.

In order to maximize the number of matched pairs that could be recovered at the end of the demonstration, all the blue-stock was forced into a single final leather product. All sides were split to 2.1 mm and shaved to 1.8 mm. As a result, some of the sides ended up being very thin in the flanks. However, since this was a matched side test this was true of both the brine-cured side and matching irradiated side. Random samples were taken from both types of sides for pH, moisture, chrome, and chrome leachibility. The bluestock was separated into matching pairs and all of the sides were evaluated for quality.

Evaluation of Bluestock (St. Joseph)

The Evergreen blue stock appeared generally to be darker in color than the brined sides, suggesting higher chrome uptake. Chrome analysis, however, showed that this was not the case. There was essentially no difference in pH, chrome uptake, moisture or leachibility in the two different bluestocks. The results of these analyses, performed by the Prime quality control laboratory in St Joseph, are in Table II. One or two dark lines, about a foot long and a quarter of an inch wide were observed in about a third of the irradiated bluestock immediately after wringing. These lines were no longer noticeable when the sides were reevaluated and measured three weeks later just prior to shipment to Berwick, ME, to be converted into crust leather. On about 20% or less of the Evergreen blue-stock there were also a number (10 to 20) of jagged-edged round spots about the size of a grape that were a little darker than the background. These were still visible when the bluestock was placed in the drum for processing into crust but was not evident in any way in the dried crust.

TABLE II
Chrome and Moisture Measurements on Bluestock from Evergreen and Brine-Cured Cattle Hides

Measurement	Brine	Evergreen
pH	3.43	3.38
Moisture	64.99%	58.16%
Chrome	4.92%	4.82%
Leachable chrome		
With Water	9.8 PPM	7.0 PPM
With TCLP	52.5 PPM	65.0 PPM

TABLE III
Bluestock Weight, Area and Evaluation for Cutability. Prime, St. Joseph, MO

Measurement	Brine	Evergreen	Change,%
Weight (lbs)	22.27	21.65	-2.78%
Std Dev	1.63	1.54	
Area (Sq Ft)	21.26	21.44	0.85%
Std Dev	1.55	1.41	
Evaluation (1-5)	2.56	3.02	
Std Dev	1.26	1.28	

The blue-stock from both preservation methods was evaluated for draw, neck wrinkles, hair stubble and scud. In the written summary evaluation provided by the Technical Manager of Prime, St. Joseph, the differences in each of these four areas were insignificant. His opinion was that, "It would be very difficult to differentiate between the two curing systems with regard to the blue inspection carried out. The blue made from both cures were well laid out and the differences seen were well within the differences seen on regular production runs.

Bluestock Area, Weight and Grade

In the bluestock only 81 matched sides were used in the area comparisons. If there was any doubt about the confirmation of a matched pair it was removed from the calculations. In the crust leather stage we were able to positively identify 114 of the matched pairs.

Comparison of the matched Evergreen sides to the brine sides showed on average a little less than half a point lower quality on the five point scale in favor of the brined hides (Table III). This grading was performed immediately after tanning as the blue stock was run though the wringer. The average difference is small compared to side-to-side variations. The standard deviation of the grade was 1.26. It should be noted that this grading was done immediately after tanning while the Evergreen blue stock still retained some of the markings that later vanished.

The area calculations resulted in a slight advantage for Evergreen of about 0.85 percent (Table III). The weight of the brine-cured sides going into the soak was about half a pound less than the Evergreen sides but after tanning the brine stock was half a pound heavier. This result is reflected in the moisture content of the two different blue-stocks.

TABLE IV
Stock Weight Variations During Processing

Process	Evergreen Total Wt*,lbs	Evergreen Side (Avg), lbs	Brine Total Wt*, lbs	Brine Side (Avg), lbs
Side Weight	4854	32.36	4854	32.36
Container Wts Leaving Schuyler	4837	32.75		
Load Wt into Drum for Bactericide.	4906	32.71		
After Three Weeks Storage	4503	30.02	4380	29.2
Shrinkage	7.23%		9.77%	
Blue-stock After Wringing	3216	21.44	3340	22.27

*Sum of individual sides

Weight Variations During Processing

The variations in total and individual side weights were tracked from the original weight in the packing plant through the blue. The results are in Table IV.

Color/Fatliquor/Retan and Finishing

On the first day at the Berwick facility the bluestock was resorted and 114 matched pairs were definitively determined. Lost matches were due to a number of reasons but the most common was that one or more of the punched holds did not penetrate through to the grain surface; identification was lost. The unmatched sides were processed into a light tan (brown) crust.

Bluestock Area

At St. Joseph the average area of the brine side was 21.26 sq ft (81 pairs) and the area of the Evergreen was 21.44 sq ft. The area measurement of the same blue-stock in Berwick for 114 pairs was 21.44 sq feet for the brined sides and 21.50 sq ft for the Evergreen. This is a 0.84% greater area for the Evergreen hides. The differences are very small in both locations, which only reinforces the accuracy of the measurements. Results are in Table V.

TABLE V
Bluestock Area Measurements. 125 Matched Pairs, Prime, Berwick and 81 Matched Pairs, Prime, St. Joseph

	Brine	Evergreen	%
Prime, Berwick			
Area (Sq Ft)	21.44	21.50	0.28%
Std Dev	1.14	1.39	
Prime, St Joseph			
Area (Sq Ft)	21.26	21.44	0.84%
Std Dev	1.55	1.41	

TABLE VI
Crust Area Measurement, 114 Matched Pairs, Prime, Berwick. Comparison with Bluestock Area Measurement

	Bluestock Area (Sq Ft) Std Dev	Crust Area (Sq Ft) Std Dev	Change %
Brine	21.44	22.38	4.20%
	1.14	1.09	
Evergreen	21.44	22.23	3.55%
	1.41	1.12	

Bluestock Grading

Thirty matched pairs of blue-stock were graded for draw, neck wrinkles, veins, stains and hair. The same thirty pairs were to be reevaluated after the leather was in the crust. The results in Table VI show a slightly greater draw, slightly more neck wrinkles and less hair on the Evergreen sides compared with the brined sides. Overall the differences are small and probably not significant. One clear difference in the Evergreen sides was the presence of the round spots on about 20% of the sides. There were none in the brine-cured sides. As a result of the high incidence of these spots in the Evergreen sides, it was decided to color all of the unmatched sides into a light tan crust. This crust would be very sensitive to stains and grain defects and it was expected that these apparent stains would show up in the leather.

Crust Area

In order to maximize the value of the leather produced in this demonstration, Prime converted all of the matched sides into a black side leather crust. They were all colored/fatliquored/retanned in the same drum. All sides were vacuum-dried, reconditioned and re-dried on a

Dynavac™ vacuum dryer. The area of each side in the crust was measured and recorded by side number. Samples of crust leather, 8" by 4", were cut from all pairs of matched sides from the black crust leather for physical testing. The remainder of the sides that were not matched were colored into a light tan crust. This was done to determine the impact of the small rounded spots described earlier on the crust leather and to highlight the effects of draw. Unlike black, which can cover up many surface defects, a light tan color is very sensitive to grain defects and discolorations. Only the highest quality hides can generally be put successfully into a light tan aniline selection. The crust leather area of the Evergreen was slightly less (0.8%) but not significantly different from the crust leather from the brine sides (Table VI).

Quality Grading of Crust Stock

Twenty-six of the thirty matched pairs evaluated in the blue were recovered in the crust. They were again evaluated for draw, neck wrinkles and hair. The most significant finding in this entire demonstration was that the Evergreen hides had significantly less draw than the brined hides. Based on the standards used by Prime, most of the Evergreen crust, based on the level of draw, could be used for any product line they manufacture. In the light tan crust leather the results were even more conclusive. Neck wrinkle and hair evaluations suggested there is no relationship between these factors and the curing method. The blue spots described earlier were not visible in either the black or light tan crust leather. This black crust is a good cover for many defects and these results were expected. The result obtained with the light tan crust was very positive but unexpected. The origin of the blue spots is not known but they din not cause any problems. Another difference observed between the crust leather produced from the Evergreen sides compared to the brine-cured sides was that while the texture and feel were similar for both there was a slight but palpable increased "firmness" in the Evergreen leather. This appears to be neither good nor bad.

Grading of Finished Leather

The finished leather was graded for cutability only. Each piece was graded as A, B, C, or D with a factor times the area of the hide to produce a yield factor. There was no difference between the two preservations. However, this is more a matter of selection of the black finish rather than a lack of difference in the leathers.

Draw, the biggest difference we found between the Evergreen and the brined hides, had not been noticed previously because experiments had not been done on such a large scale. Evergreen-processed hides have always appeared to be the equivalent of fresh hides. In some tanneries processing both fresh and cured hides it is found that fresh hides have similar or slightly more draw than brined hides and draw affects the cutability of the leather. What we found in this test was a significant decrease in the draw in the crust leather from Evergreen sides. For this demonstration, in order to reduce a loss in value for this set of sides, a decision was made by Prime to use a finish system that covered up the draw to increase the overall cutability of the entire lot. In doing so the measured cutability of the both the fresh and Evergreen was the same. If an aniline or clear finish product had been selected, there would have been a difference, with the cutability of the brine being significantly less than the Evergreen. A second advantage of the reduced draw is flexibility in selection of the leather product line. Tanners can maximize revenues if they can put hides into any product. Significant draw either has to be covered up, which reduces the selection possibilities, or cut out, which lowers the amount of the leather that can be sold. In this study, this economic difference can only be speculated on and not quantified. Our impression in our discussion with the staff at Prime is that reduced draw may have much more economic significance than the 3% area change we were expecting.

Physical Testing of Crust Leather (USDA)

Samples from all of the matched pairs in the crust were tested for tensile strength and elongation. Physical testing of leather samples for tensile strength and ball burst was done on an Instron Model 1122. These procedures are described in ASTM Standard D 2209-80, Tensile Strength of Leather (approved 1976) Vol. 1, CRC Press, Inc., Boca Raton, FL (1983). Elongation data were extracted from the test results for physical strength.

TABLE VII
Physical Test Measurements of Black Crust, 114 Matched Pairs, USDA, Wyndmoor

	Brine	Evergreen	Change
Tensile Strength	14.94	14.20	-5.21%
Std Dev	2.97	2.29	
Extension	38.21	36.23	-5.47%
Std Dev	4.23	3.56	

The initial results of this test showed a mathematically significant decrease in strength for the Evergreen sides of about 5% (Table VII). A tensile strength loss was a possibility anticipated as a result of the double-sided irradiation. This is of concern to the tanner, who must strive to prevent rejects of leather due to low strength characteristics. The concern with any overall decrease in strength would be an rease in rejected samples. A secondary analysis of the a was done taking all of the individual strength results l plotting them to form a Gaussian Distribution Curve. e result was that the tensile strength values at the low end the curve were equal or better for the Evergreen comed to the brined-cured sides (Figure 1).

ere would have been fewer Evergreen rejects compared brine in the bottom 20% of the sides. The effect of the adiation seems to have been to shift the bell curve to the t but tighten it so that there was no increase in the lowd values. A similar difference was observed in elongation t this is not considered a problem of the same magnitude. ised on our earlier studies, there would be no measurable fect of irradiation on the leather strength at a level of 1.5 rad or less single-sided. As a result of the double-sided adiation, a portion of some sides may have been exposed over 3 Mrads. This is in a range where some effect on iysical properties could be expected but the nonmogenity of the stack of hides may have mitigated the se increase.

valuation of Finished Leather

leather finishing system was selected to minimize any itting losses due to draw. The difference in draw in these athers has already been discussed. The finished leather roduced from the black crust was considered fully equivant to normal production of this product. The finishing sysm selected was successful in that the cutability of the ather from both the Evergreen and the brine-cured sides as equivalent. This would not have been the case for ghtly colored finished leather such as a light tan, where uch of the draw would have been removed and significant ower cutability values would have resulted for the brineured sample. It is in this latter situation where the ncreased value of the Evergreen process seems to be quite mportant.

Recommendations

The reproducibility of the draw results must be confirmed. This can be done with a test that is much simpler that the one just completed. It could be done with 100 hides, sided o produce irradiated and brine-cured sides, using a single sided dose of 1.5 Mrads. Hides would be sided and only the brined hides on an alternating left/right basis marked as opposed to individual numbering of each side to differentiate the brined hides. Changes in procedure would include he addition of a fungicide to the bactericide treatment in drum. Larger bags would be procured for proper four layer folding and the bagging would be done with a reliable commercial thermal bag sealer. All the sides would be dyed into a light tan to quantitatively compare the cutability of top grade leather. Additional dosimetry would be done to quantify the max/min ratios under the single-sided irradiation.

Conclusions

Three weeks after treatment, when the irradiated sides were removed from storage, they appeared to be as fresh and clean as they were just after flaying. Manufacture of crust and finished leather from all sides proceeded without special handling to produce equivalent products. This means that the Evergreen process can be used successfully to preserve cattle hides without salt to yield commercial grade leather. This would result in a cleaner environment through the elimination of salt for curing.

There was no consistent quality differences observed between the Evergreen treated and the brine-cured side after chrome tanning in the blue. Final area yield in the blue and in the crust after drying was the same for both curing treatments. The expectation of a three percent yield increase for Evergreen over brine-curing, based on a 1980 USDA study of the yield of brine?cured compared to fresh hides, was not realized. There are at least two possible explanations for this result. It may be due to the low temperature vacuum-drying methods used to prepare the crust leather in this test. The majority of leather manufactured today is either toggle-dried or paste-dried at much higher temperatures. Since high temperature tends to increase leather shrinkage the possibility still exists that the area difference seen in the earlier research done will be seen again when leathers are dried at higher temperatures.

The crust and final leather produced from the Evergreen hides was equivalent to normal production with the exception that there was significantly less draw in the Evergreen sides than in the brine-cured sides. It is generally accepted that the degree of draw found in fresh hides is either greater or the same as found in brine-cured hides. Reduced draw translates into more usable (cutable) leather that can be obtained from a hide for manufacture of leather products. The impact of reduced draw would be greatest on the more valuable leathers made with clear finishes. It also means more flexibility in choosing the final line of leather products to be made from any starting load of bluestock. Draw-free hides would be expected to generate increased profits for tanners from this flexibility and reduced waste. The value of this difference observed in draw could well exceed the value of the three percent total area difference referred to earlier.

It is important that the reproducibility of these results be

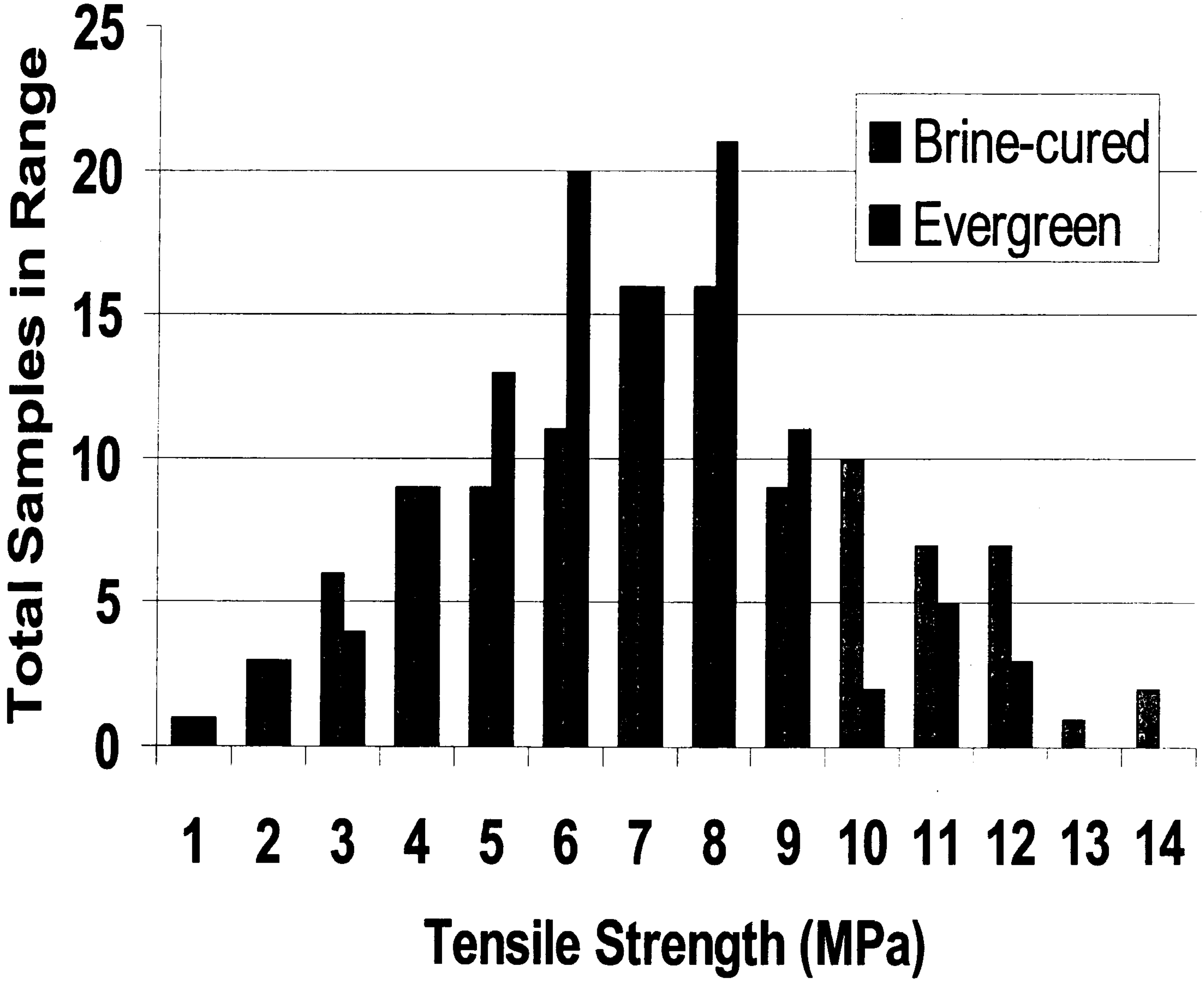

FIGURE 1. Comparison of tensile strength of finished leather samples from 108 matched sides.

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Convention Discussion

John Moynihan, Shoetrades Publishing Co.: Quite some time ago with regard to preservation economics, we first came up with the concept of wet blue. We took an awful lot of time in production establishing operating conditions. We had a facility that made wet blue. Essentially we had a whole new commodity. What would be the economics of this process?

confirmed by additional testing.
It is like bluing and I am not sure how many people are aware of it. The reason that IBP is not making brine cured stock is because they couldn't handle the effluent from the brine curing. They had to do something and that's where they went. They established the wet blue based on selling to people on the basis that we will make you what you want - to your specifications. Monfort had similar problems. They did not have as much of a market as expected originally. I think that was partially because they were trying to market a commodity. Electron-beam irradiation is another way out of the problems with brine curing. It will give a hide supplier an opportunity to avoid brine curing.

John Moynihan, Shoetrades Publishing Co.: How long did you store hides without salt?

Less than a year. And in this case as I mentioned before, someone must spring for the $8 to 10 million for a radiation facility provided a hide supplier will guarantee them a number of hides over a period of years at a certain price that would have to be negotiated.

John Moynihan, Shoetrades Publishing Co.: Could this be done in another radiation facility?

It would have to be a facility built specifically for hides because you can't mix food with the hides. The electron beam facility can be centrally located. You don't have to have one at every packing plant. If you took hides and treated them in St. Joe, you could ship them all the way to New Jersey to irradiate them. So they would not have to be irradiated next to a packer. At least a portion of them could be used to satisfy the market.

Bill Prentiss, retired: Some years ago we were trying to use a material that was called bat. That kind of thing would eventually complex with protein. Even so, there were quite a few ways of preventing bacterial growth using that kind of a process. It would probably last for a period of time and keep the bug count quite low. The data of particular interest to me is the range of weight of hides that you used in this particular test. I remember seeing numbers regarding the depth of penetration. What thickness could you irradiate?

92% of the hides weighed between 72 to 58 pounds. Actually, this is only a surface phenomenon. The interior of the hide is sterile. It really doesn't matter how thick they are as long as you get both surfaces of the hide covered with bactericide.

Rodney Hammond, Seton Co. - Leather Division: This is a very interesting topic. You said that the hides could be processed at the tannery the same as fresh hides. I presume that there will be a reduction in the time required for rehydration in the soak. Our main concern is square footage. Did you do any evaluation to see whether there is any change in area on storage.

Not extensively. The hides were 3 weeks after brine cure and 3 weeks after irradiation. However, we would not expect any deterioration and we didn't see any.

Zina Bulbuc, Garden State: You mentioned that the irradiated hide would be drier than the raw hide. What level of moisture would you expect?

We didn't actually do drying. We put the hides through a wringer. The idea is to just get the excess moisture off. We are not taking any moisture out of the hide itself. It is just dripping wet when it comes out of the bactericide application.

Zina Bulbuc, Garden State: Did you make any study of the penetration of bacteria?

The bactericide itself penetrates the hides as well as the bacteria. So the initial treatment with bactericide holds down the level of bacteria. We have done this with many different aspects in the pilot-plant tannery and the bactericide treated hides in two days smelled just as clean as fresh hide. The bactericide works very well. So penetration of the bacteria didn't make a difference. We didn't see any.

Doug Morrison, Westfield Tanning: Dave, first of all congratulations. I think that this is one of the beneficial long-term research projects from the USDA. I know that you have been working on this project for at least several years. It is nice to see the continuing development. My question is related to draw. You showed on your research report that there was draw. It surprised me that electron beam irradiation would produce draw. It would seem to me that exposing the hides to bactericide might produce draw. The hides are placed in a drum with the bactericide and you run it. Was water added or just the bactericide added to the raw hide?

There was 100% float and 0.3% bactericide.

Doug Morrison, Westfield Tanning: What was the running time?

One hour.

Doug Morrison, Westfield Tanning: Is that where all of the draw comes from -the one-hour processing with the bacteri-

cide? If you took out the one-hour processing with the bactericide and went straight to the electron beam irradiation, would you eliminate draw? Have you tried that at all?

The draw is pretty minimal. I don't believe that you get draw from the bactericide. Ultimately, I think that the processing produces draw.

Doug Morrison, Westfield Tanning: You can't just take the raw hide from the animal and irradiate it?

No. In order to kill all of the bacteria on the hide without pretreatment, the irradiation level is so high that you will damage the hide.